ORIGINAL

Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C.

In the Matter of the	)	
	)	
Revision of Part 15 of the	)	ET Docket No. 98-153
Commission's Rules Regarding	)	
Ultra-Wideband Transmission Systems	)	

COMMENTS OF XM RADIO INC.

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Summary

XM Radio Inc. ("XM Radio") hereby comments on the Commission's *NPRM* regarding rules for the use of ultra-wideband ("UWB") technology. XM Radio urges the Commission to modify its proposed rules to protect consumers of the satellite Digital Audio Radio Service in the 2.3 GHz band in the same manner as the Commission has protected consumers of broadcast TV and radio and other pervasive communications services that operate below 2 GHz. DARS is a consumer-oriented mass media service that, like TV and radio, needs virtually 100% availability. If DARS listeners experience chronic interference and disruptions of audio, even if those interruptions are intermittent and for a short duration, high quality service will be lost.

Not only does DARS require almost 100% service availability, DARS radios will be particularly vulnerable to interference from UWB transmissions. The downlink signal power available to the satellite DARS receiver is much lower than terrestrial-based communications systems, and, as a wideband communications service, DARS receivers can be designed with only limited ability to filter out undesired signals and thereby avoid interference. In addition, a significant proportion of unlicensed UWB devices will likely be used in mobile and residential environments, potentially in close proximity to omnidirectional DARS receivers operating in automobiles and within the home.

In order to protect DARS against interference from unlicensed UWB devices, the Commission should prohibit UWB devices from transmitting below 3 GHz. This restriction would greatly diminish the risk of interference to DARS reception by providing a sufficient gap band for the XM Radio service. As a general matter, a 3 GHz threshold is far more reasonable than the Commission's proposed 2 GHz limit, since the spectrum below 3 GHz is more heavily used than the frequencies above that threshold, and since it is above that threshold that most radio receivers rely largely on directional antennas

It is appropriate for the Commission to adopt a policy so protective of existing licensed services. Not only have UWB proponents failed to demonstrate that they can avoid interference to existing, licensed services, XM Radio understands that this 3 GHz threshold would not prevent most types of UWB devices from realizing their intended function. While XM Radio appreciates that a requirement to shift transmissions to the spectrum above 3 GHz may impose added costs on prospective UWB designers and manufacturers, it does not appear that such costs will be prohibitive. Clearly, the time to adopt such rules for UWB technology is now, when the vast majority of UWB devices are merely in the early design phase; at this early stage, UWB manufacturers will likely be able to adapt to this frequency restriction without jeopardizing the quality of their products' performance or their commercial viability.

If the Commission does permit UWB transmissions across the DARS band, it must at least limit such emissions in the 2.3 GHz band to a field strength level of 18 uV/m at 3 meters to provide DARS with reasonable protection from interference.

Before the Commission can permit any other use of UWB, it must develop a complete technical record. Unless the Commission has a full understanding of the nature of UWB transmissions, it will be unable to adopt rules that prevent interference to authorized services, as is required under the Communications Act and the Commission's own rules. Unfortunately, the *NPRM* establishes an October 30, 2000 deadline for the submission of any studies on the potential interference effects of UWB technology, a timetable that is far too accelerated to permit meaningful study and analysis. Given the wide variety of UWB devices that are currently contemplated and the still-experimental nature of this technology, XM Radio believes that a more realistic deadline for such research would be January 2002.

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COMMENTS OF XM RADIO INC.

XM Radio Inc. ("XM Radio") hereby comments on the Commission's Notice of Proposed Rulemaking ("*NPRM*") regarding rules for the operation of new types of products incorporating ultra-wideband ("UWB") technology. XM Radio urges the Commission to modify its proposed rules to protect consumers of the satellite Digital Audio Radio Service in the 2.3 GHz band in the same manner as the Commission has proposed to protect consumers of broadcast TV and radio and other pervasive communications services that operate below 2 GHz. DARS is a consumer-oriented mass media service, designed to provide subscribers with high-quality, uninterrupted digital audio service. Based on its preliminary understanding of UWB applications, which remain largely undefined, XM Radio believes that the Commission must either prohibit UWB operations below 3 GHz or limit emissions from such devices into the DARS band to a field strength level of 18 uV per meter at 3 meters in order to ensure that UWB transmissions do not cause harmful interference to DARS receivers. Given the embryonic state of UWB communications technology, the designers and manufacturers of these devices should be able to comply with such requirements. XM also urges the Commission to conduct or oversee comprehensive technical tests that demonstrate that the full range of UWB technologies can be used without causing harmful interference to DARS and other licensed radio services.

Background

The Development of DARS in the S-band. In 1995, the Commission allocated spectrum in the S-band to the satellite Digital Audio Radio Service, and in 1997 licensed two entities, XM Radio and Sirius Satellite Radio ("Sirius Radio") to provide this service in the United States.[1] As the Commission has repeatedly recognized, this new consumer-based mass media service promises enormous public interest benefits for the U.S. public. Satellite DARS will provide high-quality, continuous, nationwide multichannel audio service. The availability of DARS will increase the variety of programming available to the listening public, offering an unprecedented variety of music and information, including in areas of the country that have traditionally been underserved by terrestrial radio stations.[2]

Since their licensing, XM Radio and Sirius Radio have made extraordinary progress in the development of their DARS systems. Both licensees are now fully funded through their scheduled initiation of commercial service, having raised in the aggregate more than $2 billion. Construction of both systems is advanced. With its second launch early in September, Sirius Radio has now successfully launched two of its three satellites. Service is expected to begin within months. In addition, DARS subscribers will invest in the service by purchasing or leasing and installing appropriate satellite DARS receivers. In the aggregate, these investments will total billions of dollars.

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1 American Mobile Radio Corporation, 13 FCC Rcd 8829 (Int'l Bur., 1997); Satellite CD Radio, 13 FCC Rcd 7971 (Int'l Bur., 1997). The Commission allocated spectrum in the S-band to DARS in 1995, and XM Radio and Sirius Radio were the winning bidders in the DARS licensing auction in April 1997, together committing nearly $170 million to the U.S. Treasury.

2 Report and Order, Memorandum Opinion and Order, Establishment of Rules and Policies for the Digital Audio Radio Satellite Service in the 2310-2360 MHz Frequency Band, 12 FCC Rcd 5754, para. 1 (1997) ("*DARS Order*").

Reception of DARS depends on the transmission of wideband signals from a satellite to a very small aperture omnidirectional antenna operating in a mobile environment under fading conditions. While XM Radio's satellites are state-of-the-art and among the most powerful communications satellites ever manufactured, the downlink signal power available to the receiver is much lower than terrestrial-based communications systems. As a result, DARS receivers are very sensitive to interference, a condition that is described in further detail in the Technical Appendix to these Comments.

Consumer-oriented mass media services such as DARS have availability requirements near 100%, much greater than the availability requirement for mobile telephony systems. While people using mobile phones have accepted the fact that intermittent outages or bursts of noise occur during the course of a conversation, such disruptions will not be tolerated by a DARS subscriber who is listening to music. Unfortunately, in the digital environment of DARS, the loss of an adequate signal can produce unacceptable disruptions in received programming.

The Commission has made clear that DARS subscribers can expect to receive high-quality service without the threat of unreasonable interference. In amending its out-of-band emissions standard for the adjacent-band Wireless Communications Service, the Commission indicated that "[i]n authorizing DARS, it was our desire to ensure a high quality radio service."[3]

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[3] Memorandum Opinion and Order, Amendment of the Commission's Rules to Establish Part 27, the Wireless Communications Service ("WCS"), 12 FCC Rcd 3977, para. 25 (1997) ("*WCS Order*").

The Commission further stated that

> [w]e [recognize] that the 2320-2345 MHz frequency band is the only spectrum specifically available for provision of Satellite DARS in the United States. Accordingly, if Satellite DARS in this spectrum is subject to excessive interference, the service will not be successful and the American public will not benefit from the service.

WCS Order at para. 27.

XM Radio will provide service to its subscribers directly through its licensed DARS satellites in over 99% of its coverage area. Terrestrial repeaters will be used only to provide service in urban areas and elsewhere where it may be difficult to receive satellite-based signals due to line-of-sight blockage from foliage, buildings, and other obstacles. Even within the coverage area of the terrestrial repeater signal, there will be areas where the terrestrial signal is close to the receiver threshold.

Ultra-Wideband Devices and the Commission's NPRM. On May 11, 2000, the Commission released its *NPRM* on rules for the operation of UWB systems and devices. UWB technology is still in the development phase, with few UWB products having yet been manufactured or delivered into the marketplace. UWB radio systems typically use extremely narrow pulse modulation or swept frequency modulation that employs a fast sweep over a wide bandwidth.[4] Because of the type of modulation employed, the emission bandwidths of UWB devices generally exceed one gigahertz and may be greater than ten gigahertz.[5]

According to the Commission, UWB technology can be used for a wide variety of applications, including ground penetrating radar, collision avoidance systems on automobiles, medical monitors, and various wireless data communications systems. *NPRM* at paras. 10-12.

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4 *See NPRM* at para. 3 n.8; Notice of Inquiry, ET Docket No. 98-153, 63 Fed. Reg. 50184, para. 3 (September 21, 1998).

5 *Id.*

The Commission notes that many UWB products, including UWB communications applications, are likely to be used both in mobile environments and in residential settings.[6] *Id.* at para. 40. With respect to such communications systems, the Commission states that UWB technology will permit the transmission of very high data rates over short distances without suffering the effect of multipath interference. The Commission provides no description of the key transmission characteristics of the UWB communications systems, and there is no indication that such information is in the Commission's record or has otherwise been publicly disclosed. *NPRM* at para.12. The Commission indicates that in order for UWB devices to operate, they must be permitted to transmit over frequencies allocated to authorized communications services.[7] While such transmissions are currently not allowed under the Commission's rules, the Commission in the *NPRM* proposes to amend Part 15 of its rules to permit low power UWB operations.[8] *NPRM* at paras. 18, 39. The Commission proposes that, under its Part 15 framework, there will be as few restrictions as possible on which frequencies can be used by UWB devices, except as necessary to protect existing services from interference. *Id.* at para. 27.

Significantly, the Commission proposes that its rules for UWB operations be more restrictive below 2 GHz than above 2 GHz. *Id.* at paras. 27-30, 39. Explaining this disparate treatment, the Commission states its view that UWB devices can generally operate above 2 GHz without causing interference to other radio services. *Id.* at para. 27. The Commission attributes

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6 As the Commission points out, UWB devices could be used to wirelessly distribute services such as phone, cable, and computer networks throughout the home. *NPRM* at para. 12

7 *See, e.g., NPRM* at para. 23. The Commission defines UWB devices as "any devices where the fractional bandwidth is greater than 0.25 or occupies 1.5 GHz or more of spectrum." *NPRM* at para. 21.

8 The Commission notes that higher-power UWB applications raise numerous novel questions, states that there is insufficient information in the record to address these issues, and defers any proposal on the regulation of such high-power systems.

this relative interference immunity to supposed high propagation losses above 2 GHz, and to the fact that most radio services operating above 2 GHz use directional antennas that generally prevent the reception of undesired signals. *Id.* In contrast, the Commission states that the spectrum below approximately 2 GHz is more heavily occupied, containing numerous services that need protection from interference, including AM, FM, and TV broadcasting, public safety communications, aeronautical, and maritime navigation and communications, medical telemetry, and GPS operations. The Commission states that it has "significant concerns about the operation of UWB devices" below 2 GHz. *Id.* at paras. 28-29.

As a general matter, the Commission proposes to apply its general Part 15 emissions limits in Section 15.209 of its rules to UWB devices.[9] However, the Commission proposes that UWB emissions below 2 GHz be attenuated by at least 12 dB below these general emissions limits. *NPRM* at para. 39. The Commission asks for comment on whether this proposed 12 dB reduction should apply to all emissions below 2 GHz, or only to emissions below 2 GHz that fall within the frequency bands that are "restricted" under Part 15. *Id.* In addition, the Commission requests comment on what other UWB restrictions are necessary to protect the licensed services below 2 GHz, and on the precise frequency below which such restrictions should be applicable.[10] In contrast, the Commission proposes that there be no other restrictions on UWB devices operating at frequencies above approximately 2 GHz. *Id.* at para. 27.

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[9] The Commission also proposes to impose a limit on the peak emissions from UWB devices in order to reduce the potential for UWB emitters to cause harmful interference to radio operations above 1 GHz. Specifically, the Commission proposes to apply a 20 dB limit with respect to the maximum permitted average emission level, and also proposes that the absolute peak emission level not be permitted to exceed the average limit by more than 60 dB. *NPRM* at para. 43.

[10] *NPRM* at paras. 29, 39. The Commission asks whether, for instance, it should restrict UWB operations below the GPS band at 1610 MHz, or, alternatively, below the PCS band at 1850-1990 MHz.

The Commission acknowledges that the establishment of rules for UWB technology requires a firm understanding of the characteristics of UWB signals, their individual and cumulative impact on victim receivers, and the minimum separation distance between UWB devices and those victim receivers. *Id.* at paras. 32, 47. The Commission notes that in an effort to increase understanding of this technology, various parties, including NTIA, are planning experimental programs to study the interference potential of UWB devices. *Id.* at para. 31. The Commission states that parties should submit their test results into the public record in this proceeding by October 30, 2000, and that it will issue a public notice to provide an opportunity for comments on such studies.[11] *Id.*

Discussion

I. Consumers of DARS Should Receive the Same Protection As Consumers of Services Below 2 GHz

The Commission's proposal to impose restrictions on the operation of UWB devices only below 2 GHz fails to account for the DARS allocation at 2320-2345 MHz. Given the service characteristics of DARS, the Commission should provide the same protection to DARS consumers as it provides to consumers of the various services below 2 GHz cited in the *NPRM*.

As an initial matter, DARS is a consumer-oriented mass media service, like TV and radio, that needs virtually 100% availability. In fact, even more than other media services, the success of DARS relies on its ability to deliver high-quality performance. If DARS listeners

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11 The Commission has elsewhere begun to acknowledge an increase in the amount of noise and the potential for interference in the radio spectrum due to the proliferation of Part 15 devices. In June 2000, prompted by government and industry experts' concern over interference from growing numbers of unintentional emissions, the Commission's Technological Advisory Council announced its interest in a study of radio spectrum noise. Public Notice, "Technology Advisory Council to Hold Fifth Meeting," DA 00-1140 (May 31, 2000).

experience chronic interference and disruptions of audio, even if those interruptions are intermittent and for a short duration, high quality service will be lost.

The Commission has traditionally placed a particular emphasis on protecting consumer-oriented communications services such as broadcast television and radio from harmful interference, and the Commission should extend this policy to DARS. For instance, in 1979, the Commission imposed a tougher emissions standard on computer devices (now called "digital devices" in Part 15) used in residential environments than on computer devices used in commercial or industrial settings; this policy was designed to protect consumers' use of televisions and radios in the home.[12] The Commission explained that "[w]hile the precise size of the benefits is difficult to measure, it is clear that the benefits of television viewing and radio services -- both services with which computers can interfere -- are substantial."[13] In addition, while the Commission has not classified the broadcast TV frequency band as a "restricted" band, it has provided broadcast TV with protection from interference by denying requests to certify unlicensed devices to transmit in the TV band.[14] The Commission also has never permitted spread spectrum devices to operate in the broadcast TV band.[15]

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12 *See* 47 C.F.R. §15.3(h), (i); First Report and Order, Amendment of Part 15 to Define and Clarify the Rules Governing Radiating Devices and Low Power Communication Devices, 69 FCC 2d 28 (1979) ("*Computer Order*"). In addition, the Commission on reconsideration stated that, "[i]n the home, the TV and AM/FM broadcast receivers are the most susceptible to interference from a computing device. For protection of radio and TV reception in the home, the Commission is adhering to the radiation limits proposed in the Notice with some relaxation at the higher frequencies." Order Granting in Part Reconsideration of First Report and Order, Amendment of Part 15 to Define and Clarify the Rules Governing Radiating Devices and Low Power Communication Devices, 79 FCC 2d 67, para. 52 (1980).

13 *Computer Order* at para. 68.

14 Report and Order, Amendment of Part 15 of the Commission's Rules to Permit Operation of Biomedical Telemetry Devices on VHF TV Channels 7-13 and on UHF TV Channels 14-46, 12 FCC Rcd 17828, para. 5 (1997) ("*Biomedical Telemetry Order*"). As an

Footnote continued on next page

Not only does DARS require almost 100% service availability, it is particularly vulnerable to interference from in-band and out-of-band emissions from unlicensed devices such as UWB transmitters. As indicated above, the downlink signal power available to the satellite DARS receiver is much lower than terrestrial-based communications systems. As a result, DARS receivers are very sensitive to interference, a condition that is described in further detail in the Technical Appendix to these Comments. Recognizing the sensitivity of satellite downlinks, the Commission has traditionally worked to protect satellite services from interference from the operation of unlicensed devices.[16] In addition, like broadcast TV, DARS is a wideband communications service, and DARS receivers can be designed with only limited ability to filter out undesired signals within its passband and thereby avoid interference.

In explaining its proposed more liberal treatment of UWB devices above 2 GHz, the Commission claims that most licensed services above 2 GHz employ directional antennas that reduce the potential for interference. *NPRM* at para. 27. In fact, however, consumer-oriented DARS receivers use omnidirectional antennas, just like broadcast TV and radio receivers and other sub-2 GHz services cited by the Commission. In addition, as the Commission indicates in the *NPRM*, a significant proportion of unlicensed UWB devices will likely be used in mobile and

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Footnote continued from previous page

exception to this policy, certain medical telemetry devices are permitted to transmit in the TV band subject to numerous strict operating conditions. *See, e.g., Biomedical Telemetry Order*.

15 *See, e.g.*, First Report and Order, Authorization of Spread Spectrum and Other Wideband Emissions Not Presently Provided for in the FCC Rules and Regulations, 1985 FCC LEXIS 4159, Gen Docket No. 81-413, paras. 7, 10 (1985).

16 *See Part 15 Order* at para. 61 n.22. In fact, several of the Commission's restricted bands are satellite downlink bands, and the Commission in 1985 specifically precluded the operation of spread spectrum devices in a portion of the 5 GHz band already allocated to FSS. *Spread Spectrum Order* at para. 24.

residential environments, potentially in close proximity to DARS receivers operating in automobiles and within the home. In the context of DARS, therefore, the shorter range of transmissions above 2 GHz is not a legitimate justification for less stringent treatment of UWB technology above that threshold.

Given all of these factors, the Commission should modify its proposed treatment of UWB technology to account for the allocation of DARS in the 2.3 GHz band. As described further below, if the Commission in fact adopts a two-tier policy for regulating the operation of UWB devices, it should shift its proposed threshold between these tiers to a frequency of 3 GHz or higher.

II. The Commission Should Either Prohibit the Operation of UWB Technology Below 3 GHz, or Adopt a Stringent Emissions Limit of 18 uV/m at 3 Meters in the 2.3 GHz Band

Given the sensitivity of DARS radios to interference and their need for protection from transmissions from unlicensed devices, XM Radio believes that the Commission should preclude the operation of UWB devices in the vicinity of the DARS band at 2.3 GHz. Specifically, XM Radio urges the Commission to prohibit UWB transmissions below 3 GHz. By restricting UWB operations below that threshold, the Commission would greatly diminish the risk of interference to DARS reception by providing a sufficient gap band for the XM Radio service.

As a general matter, this threshold is far more reasonable than the 2 GHz limit proposed by the Commission. Counter to the Commission's statement in the *NPRM*, it is in fact above the 3 GHz threshold that most radio receivers rely largely on directional antennas, making those receivers more resistant to interference than their omnidirectional counterparts. Services above this threshold which utilize highly directional antennae include Point-to-Point Microwave service, the Fixed Satellite Service, and Direct Broadcast Satellite service. In addition, the

spectrum below 3 GHz is more heavily used than the frequencies above that threshold, and there will be a lower risk of harmful interference to licensed services above that frequency.

It is appropriate for the Commission to adopt a policy so protective of existing licensed services. Before the Commission can consider overlaying UWB transmissions on top of the DARS frequency band and other bands used for a variety of critical radio services, the developers of this technology must provide full disclosure regarding likely UWB transmission characteristics and demonstrate that operation of their contemplated UWB products will not cause harmful interference to such licensed services. To date, UWB proponents have not done so. The burden of proof here should fall squarely on these parties, who in many cases have failed to show even that their proposed UWB applications offer operational advantages over traditional narrowband systems using discrete frequencies.

Further supporting this proposed restriction below 3 GHz is the fact that manufacturers of UWB devices should be able to comply with such a prohibition. (In contrast, XM Radio would be unable to take any steps to avoid interference from UWB transmissions in the DARS band.) With the exception of ground penetrating radar and other imaging devices, XM Radio understands that this rule would not prevent most types of UWB devices from realizing their intended function, even devices that their designers currently intend to operate on lower frequencies in the vicinity of 2 GHz.[17] While XM Radio appreciates that a requirement to shift transmissions to the spectrum above 3 GHz may impose added costs on prospective UWB

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[17] According to the Commission, such radar devices must operate at frequencies in the region below 2 GHz in order to obtain the penetration depth and resolution necessary to detect and obtain the images of buried objects. *NPRM* at para. 25. The Commission has therefore proposed to all GPRs to operate in any part of the spectrum, and XM Radio does not oppose this proposal. *Id.*

designers and manufacturers, it is necessary to impose reasonable costs on developers of these new RF applications in order to protect existing licensed services.

The time to adopt such rules for UWB technology is now, when the vast majority of UWB devices are merely in the early design phase and there has yet to be any commercial implementation of these devices. At this early stage, UWB manufacturers will be able to adapt to any frequency restrictions necessary for the protection of licensed services, in all likelihood without jeopardizing the quality of their performance or their commercial viability. If the Commission instead waits until UWB devices have been deployed and DARS and other licensed services have experienced substantial interference, the cost of the necessary modifications to UWB devices will be far greater.

If the Commission does permit the operation of UWB devices that transmit across the DARS band, XM Radio believes that such emissions should be limited to a field strength level of 18 uV/m at 3 meters. As explained in the Technical Appendix, this is the emissions limit that is required to provide DARS receivers with reasonable protection from harmful interference from UWB transmissions.

III. Before Use of UWB Technology is Permitted Otherwise, There Must Be Technical Analysis That Demonstrates Conclusively That UWB Operations Will Not Cause Harmful Interference to Authorized Services

Before the Commission can permit any other use of UWB, it must develop a complete technical record. Unless the Commission has a full understanding of the nature of UWB transmissions and their individual and cumulative effects on receivers in licensed services, it will be unable to adopt rules that prevent interference to authorized services, as is required under the Communications Act and the Commission's own rules. In particular, the Commission should require developers of higher power UWB communications applications, which pose the greatest

threat of interference to licensed services, to provide full disclosure regarding their products' likely transmission characteristics, including pulse frequency, pulse width, apparent frequency range, and other key technical parameters.

At the moment, the Commission seems unwilling to develop such a technical record. While it acknowledges the need for research on the potential effects of UWB operations on licensed radio services (which includes DARS), the Commission does not appear to appreciate the time and effort that are required to conduct the necessary studies and prepare comprehensive analyses of the resulting data. The *NPRM* establishes an October 30, 2000 deadline for the submission of any studies on the potential interference effects of UWB technology, a timetable that is far too accelerated to permit meaningful study and analysis. Given the wide variety of UWB devices that are currently contemplated and the still-experimental nature of this technology, XM Radio believes that a more realistic deadline for such research would be January 2002.

Conclusion

For all of the aforementioned reasons, the Commission should adopt the aforementioned rules and policies regarding the operation of ultra-wideband devices.

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TECHNICAL APPENDIX

I. INTRODUCTION

In this Technical Appendix, XM Radio Inc. ("XM Radio") addresses a number of issues relating to the operation of its DARS system in the 2332.5-2345 MHz band and the potential vulnerability of this system to interference from ultra-wideband ("UWB") transmitters. Below, XM Radio describes the technical characteristics of its receivers and licensed DARS system, assesses the likely effects on this system from UWB transmissions at FCC-proposed emissions levels, explains why UWB transmissions should be largely prohibited below 3 GHz, and proposes emissions limits for UWB transmissions below 3 GHz if such operations are permitted.

II. CHARACTERISTICS OF XM RADIO'S DARS SYSTEM AND ANALYSIS OF THE EFFECTS OF THE PRESENTLY PROPOSED EMISSIONS LIMITS FOR UWB TRANSMITTERS

The FCC has proposed to apply its emissions limits in Section 15.209 to UWB devices. The current Section 15.209 emissions limit above 960 MHz is 500 microvolts per meter at 3 meters. This limit equates to an out of band emissions level of –41 dBm in a 2 MHz measurement interval.

In response to the FCC's request in paragraph 33 of its NPRM, XM Radio provides the following information regarding its system and receiver operations and the likelihood of interference from UWB transmissions. (The issues are listed in the order presented in paragraph 33.) XM Radio's analysis addresses the case where UWB transmissions raise the noise floor of the XM Radio receiver.

(Please note that there is great uncertainty regarding the technical characteristics of the variety of UWB emitters being considered for communications applications, and that XM Radio has deep concerns if the PRF comes near to its DARS bit rates. If that is the case, UWB emissions must be treated as pulsed signals that will potentially capture XM Radio's receivers. In that context, the impact of peak power of UWB emissions needs to be considered in addition to the overall increase of the in-band noise floor, since either will reduce service reliability.)

1) Typical desired signal strengths at the Receiver:

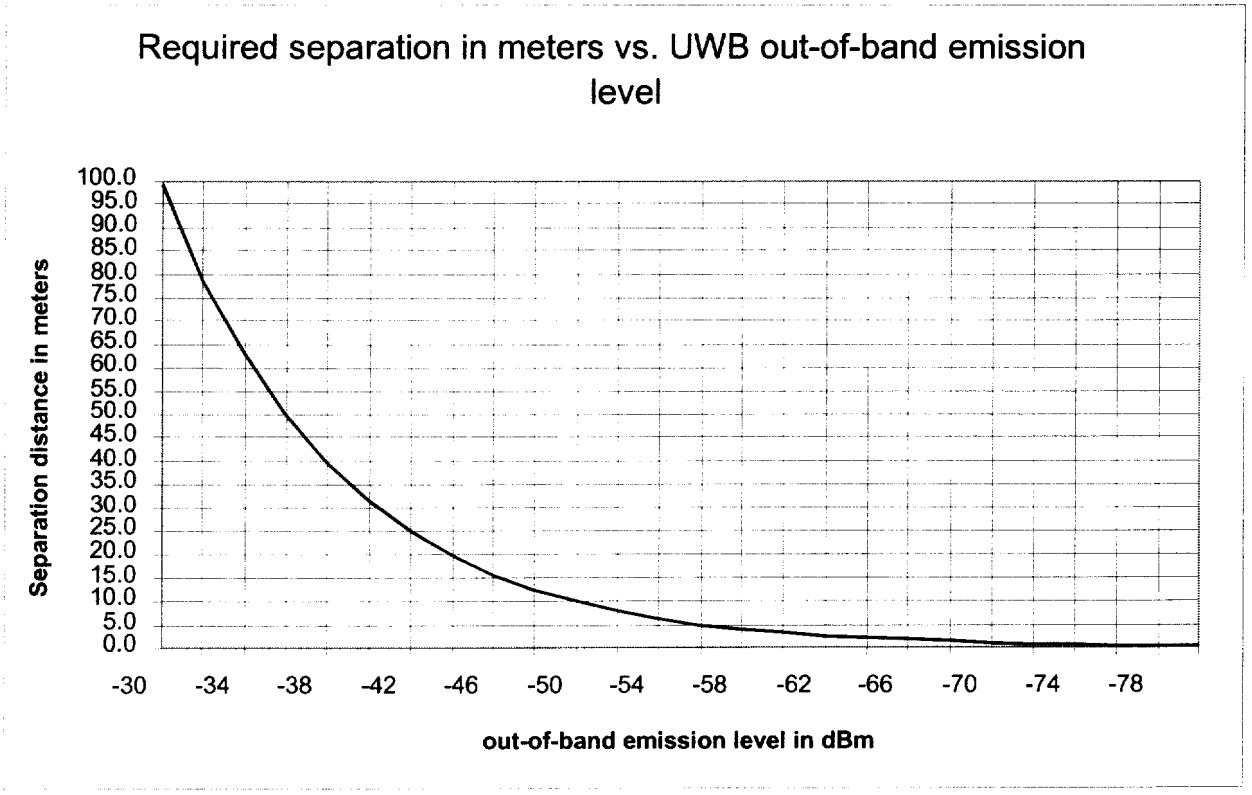
The XM satellite service is a mobile direct broadcast satellite service. This type of service inherently operates at a very low signal to noise margin. The XM satellite receiver architecture allows operation at S/N levels as low as 3 dB. Therefore, any increase in the noise floor has the potential to have a detrimental effect on service reliability. The typical SATELLITE RF LEVEL is the following (referenced to the input of the 50 Ohm antenna element, where the radiating element is attached): -109 dBm to -90 dBm (RF = 2332.5 MHz - 2345 MHz) - Signal BW = 1.886 MHz

2) Receiver inherent noise level or noise figure:

XM Radio's receiver NF is equal to 1.2 dB. The value of thermal noise at the XM Radio receiver input is -110 dBm (300 degree noise temperature and 2 MHz noise bandwidth). The

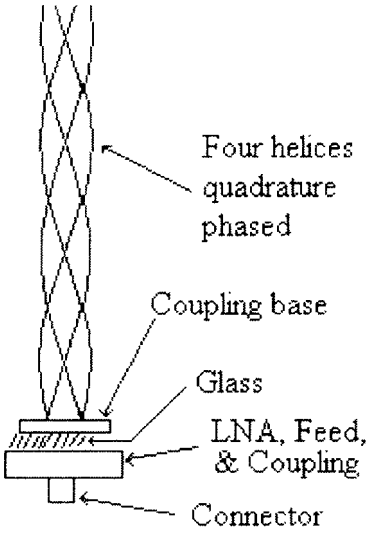
additional increase of the noise floor in the DARS band due to the allowable out-of-band emissions reduces the available DARS satellite link margin. This indicates the isolation required between a UWB radiator and the DARS receive antenna is 69 dB.

The following chart illustrates the separation distance between a UWB radiator and a DARS receiver in a line of sight condition that is required to provide the level of isolation required to ensure that the UWB out-of-band emissions are below the thermal noise of the DARS receiver. This isolation limits the effect of UWB out-of-band emissions on the reliability of the DARS service. As shown below, at a UWB emitter level of –41 dBm, the separation distance required to ensure that the out of band emissions would not interfere with the DARS receiver would be approximately 35 meters.

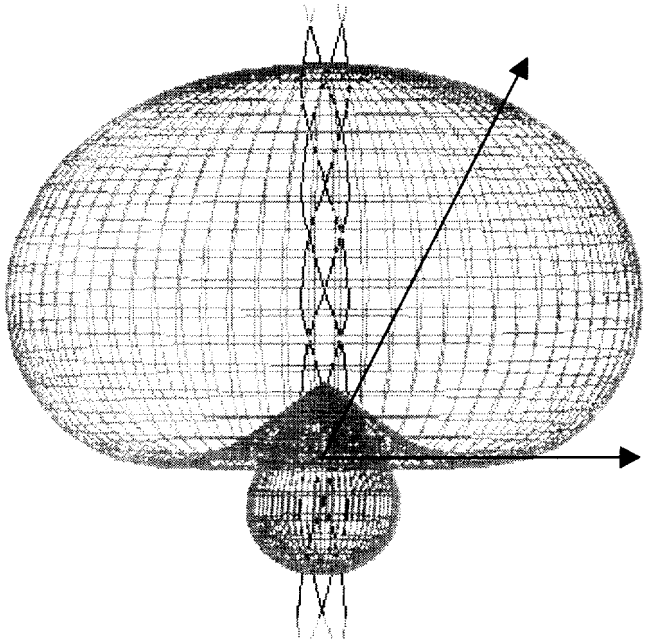


3) Typical antenna patterns for the system and frequency response of the antenna for out-of-band signals indicating expected differential antenna gain for UWB signal and desired signal if applicable:

XM Radio uses a quadrifilar antenna with the following characteristics:

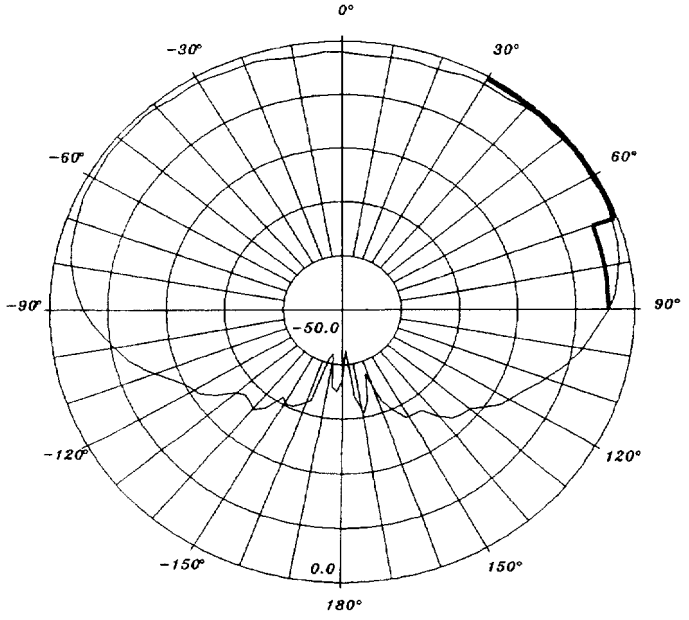


Ideal Radiation Pattern:



Antenna Passive Gain Minimums in dBic

Elevation Angle (deg.)	Left Hand Circular Polarized Gain (LHCP) (minimum over any azimuth)
0	X
5	X
10	X
15	X
20	3.0
25	3.0
30	3.0
35	2.9
40	2.8
45	2.7
50	2.6
55	2.5
60	2.0



3 dB BW = 70 MHz

Frequency response of the antenna for out-of-band signals

Data is currently being collected on the out of band selectivity of the antenna.

XM Antenna pre-selector characteristics

The pre-selector filter, on the antenna module provides 25 dB of rejection +/- 200 MHz from 2338 MHz. We also use the same filter on the XM Tuner providing at total of 50 dB of rejection +/- 200 MHz from 2338 MHz.

4) Typical front end bandwidths before the first mixer in receivers:

Satellite bandwidth before first mixer: BW (1 dB) = 12.5 MHz.

5) Typical dynamic range limits of receiver mixers – preferably third order intercept points:

XM Radio IP3 = -30 dBm

6) Typical IF bandwidths:

XM Radio IFBW = 2.5 MHz

7) Required signal-to-interference ratios for reliable performance of the system assuming interference is white gaussian noise and with others types of interference:

XM Radio Satellite Signal to Interference Radio (SI) = 12 dB

8) Required interference to noise ratio:

XM Radio Satellite Interference to Noise Ration (IN) = 67 dB

9) Minimum distance to an interference source that is not under the control of the user:

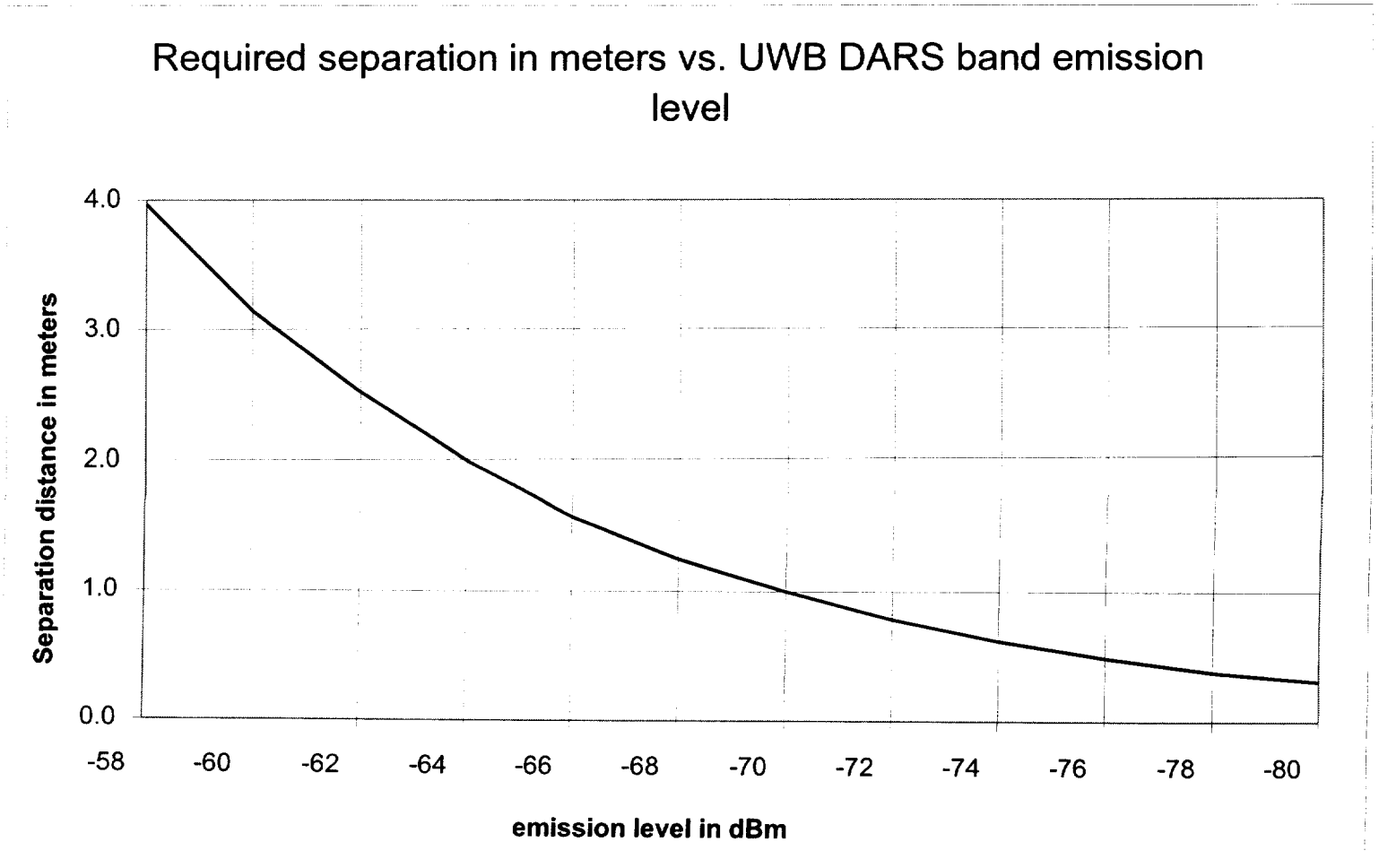
One meter for separation from portable devices (*i.e.*, the distance of a RF handset, being operated by a user, to the XM Radio antenna unit attached to the glass of a car) and TBD meters from a fixed interference source. XM Radio cannot provide more exact numbers until UWB signals are characterized. XM Radio would like the opportunity to run experiments to evaluate the potential for interference and enable the establishment of appropriate emission limits.

III. RECOMMENDATION FOR PROHIBITION OF UWB COMMUNICATIONS APPLICATIONS BELOW 3 GHZ

Due to uncertainty regarding the characteristics of the UWB devices that might be used for wideband communication purposes, including wireless data applications to residences, the Commission should prohibit UWB communications applications below 3 GHz. Such prohibition would create an adequate guardband between the DARS band and the UWB systems. It is further offered that services which presently utilize the spectrum above 3 GHz – including terrestrial microwave services, FSS, MSS, and DBS -- use highly directional antennae, and therefore those systems should more easily be able to protect themselves from UWB transmissions.

IV. RECOMMENDED LIMITS ON UWB EMISSIONS INTO THE DARS BAND

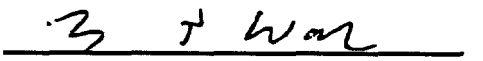
If UWB emissions are allowed below 3 GHz, XM Radio believes that an emission limit of –100 dBW, or 1.8 microvolts per meter at 30 meters or 18 microvolts per meter at 3 meters, is necessary to protect XM Radio's DARS receivers from interference. As shown in the graph below, This limit would allow co-location of UWB emitters and DARS receivers within one meter of each other. The DARS system is designed to be primarily a direct satellite broadcast system with a very high target availability (~99%) and as such operates at very low signal to noise level. As a result, any additional in-band noise impacts the service reliability.



Technical Certification

I, Craig Wadin, Senior Staff Engineer of XM Radio Inc. ("XM Radio"), hereby certify the following under penalty of perjury:

I have reviewed the foregoing "Comments of XM Radio Inc." and participated in the preparation of the foregoing "Technical Appendix," and the technical information contained in these materials is true and correct to the best of my belief.



Craig Wadin

Dated: September 12, 2000